

REMARKS

Claims 1-57 are pending in this application and have been subjected to a restriction requirement. Applicant has amended claims 4, 11, and 22-23 and added claims 52-57 via the present Amendment to better comply with the Office's requirements as well as to expedite prosecution of the present application.

The Restriction Requirement

Applicant notes the finality of the restriction requirement and the withdrawal of claims 25-51 from examination.

Drawings

The Office has objected to the drawings and has required corrected drawings for the reasons noted on page 2 of the Office Action. In response, Applicant has corrected Figures 2-4 (as noted in red) and submits the corrected drawings as required by the Office. No correction was made to the Figures to include the descriptor "22" which was a mistake in the specification. Instead, the specification was amended to remove this descriptor and replace it with "15." Thus, Applicant respectfully requests withdrawal of this objection.

Specification

The Office has objected to the title and has required a new title. In response, Applicant has amended the title. Thus, Applicant respectfully requests withdrawal of this objection.

Rejection – 35 U.S.C. § 102(b) over Shoji et al.

The Office has rejected claims 4-7, 10, and 22 under 35 U.S.C. § 102 (b) as being anticipated by Shoji et al. (U.S. Patent No. 5,928,965) for the reasons listed on page 3 of the Office Action. Applicant respectfully traverses this rejection.

Shoji et al. discloses a method for etching a silicon substrate to form “grooves” in the substrate. *See Abstract.* Time and time again, Shoji et al. describe that one purpose of their invention is to control the “tapered” shape of each groove. *See column 2, line 29 through column 3, line 11.* And the figures of Shoji et al. clearly depict the formation of v-shaped grooves, not trenches. Thus, Shoji et al. do not teach each and every limitation in the present claims, and in particular, the formation of trenches.

For the above reasons, the Office has not substantiated that Shoji et al. anticipate claims 4-7, 10, and 22. Accordingly, Applicant respectfully requests withdrawal of this ground of rejection.

Rejection – 35 U.S.C. § 103 over Shoji et al. and Yi et al.

The Office has rejected claims 1-3, 8, and 21 under 35 U.S.C. § 103 as being unpatentable over Shoji et al. in view of Yi et al. (U.S. Patent No. 5,900,163), for the reasons listed on pages 4-5 of the Office Action. Applicant respectfully traverses this rejection.

As noted above, the Office has not substantiated that Shoji et al. teach a method for making trenches. Nor has the Office shown that the skilled artisan would have considered such a limitation obvious in light of the disclosure of Shoji et al. Indeed, in light of the disclosure of

Shoji et al. to specifically form grooves, it is doubtful that the skilled artisan would have considered such a limitation to have been suggested by Shoji et al.

Neither has the Office substantiated that the skilled artisan would have been motivated to modify Shoji et al. in light of Yi et al. Indeed, in light of the express purpose of Shoji et al. to control the shape of the taper of sidewall of the grooves, it is unlikely that the skilled artisan would have been motivated to use the disclosure of Yi et al. to change these express teachings of Shoji et al.

As to claims 2 and 3, the Office argues that obtaining a depth ranging from about 1.25 to about 20 microns would have been obvious because the selection of the claimed range was a matter of determining optimum process conditions by routine experimentation with a limited number of species. Before the selection of a claimed range can be deemed obvious under this legal doctrine, however, the “particular parameter [to be optimized] must first be recognized as a result-effective variable, e.g., a variable which achieves a recognized result...” *See M.P.E.P. § 2144.05 (II)(B)* citing *In re Antoine*, 559 F.2d 618 (CCPA 1977) and *In re Boesch*, 617 F.2d 272 (CCPA 1980). The Office, however, has not substantiated that the depth of the trench is a result-effective variable. Indeed, the depth of the trench is not a result-effective variable in the claimed process of forming a trench because it is the “recognized result” of the claimed process.

For the above reasons, the Office has not substantiated that the skilled artisan would have considered claims 1-3, 8, and 21 obvious over the combined teachings of Shoji et al. and Yi et al. Accordingly, Applicant respectfully requests withdrawal of this rejection.

Rejection – 35 U.S.C. § 103 over Shoji et al. and Miller et al.

The Office has rejected claims 9, 11-19, 23 and 24 under 35 U.S.C. § 103 as being unpatentable over Shoji et al. in view of Miller et al. (U.S. Patent No. 6,218,309), for the reasons listed on pages 5-6 of the Office Action. Applicant respectfully traverses this rejection.

As noted above, the Office has not substantiated that Shoji et al. teach a method for making trenches. Nor has the Office shown that the skilled artisan would have considered such a limitation obvious in light of the disclosure of Shoji et al. Indeed, in light of the disclosure of Shoji et al. to specifically form grooves, it is doubtful that the skilled artisan would have considered such a limitation to have been suggested by Shoji et al.

Neither has the Office substantiated that the skilled artisan would have been motivated to modify Shoji et al. in light of Miller et al. Indeed, in light of the express purpose of Shoji et al. to control the shape of the taper of sidewall of the grooves, it is unlikely that the skilled artisan would have been motivated to use the disclosure of Miller et al. to change these express teachings of Shoji et al.

The Office recognizes that Shoji et al. fails to teach the recited depth uniformity, but relies on Miller et al. for such a teaching. The Office, however, has not accounted for the fact that Miller et al. obtain such a depth uniformity when forming trenches, not grooves. The Office has given no reason or suggestion why the skilled artisan would have thought the uniformity of the trench depth would have been important or advantageous in forming grooves. Thus, the skilled artisan would not have been motivated to combine the references as proposed by the Office.

The Office recognizes that the combination of Shoji et al. and Miller et al. do not teach the recited sidewall angle uniformity, trench depth variance, or sidewall angle. The Office contends, however, that these claimed ranges would have been obvious in determining optimum

process conditions by routine experimentation. Again, the Office has not shown that these parameters are result effective variables.

Further, it is doubtful that the Office can show that these claimed limitations are obvious for the following reasons. First, the Office has not shown that Shoji et al. disclose any sidewall angle uniformity and Miller et al. disclose a sidewall angle ranging between 3% (or 87%) and 5% (85%). *See Miller et al., column 15, lines 65-66.* It is doubtful that this disclosure would have suggested to the skilled artisan the claimed uniformity of 0.5% to 0.15%. Second, the Figures of Shoji et al. show grooves (with a sidewall angle nowhere near the claimed 89%) and Miller et al. describe a sidewall angle of 85 to 87%. It is doubtful that this disclosure would have suggested to the skilled artisan the claimed sidewall angle of 89%.

For the above reasons, the Office has not substantiated that the skilled artisan would have considered claims 9, 11-19, 23 and 24 obvious over the combined teachings of Shoji et al. and Miller et al. Accordingly, Applicant respectfully requests withdrawal of this rejection.

Rejection – 35 U.S.C. § 103 over Shoji et al., Yi et al., & Miller et al.

The Office has rejected claim 20 under 35 U.S.C. § 103 as being unpatentable over Shoji et al., Yi et al., and Miller et al. (U.S. Patent No. 6,218,309), for the reasons listed on pages 6-7 of the Office Action. Applicant respectfully traverses this rejection.

As noted above, the Office has not substantiated that Shoji et al. teach a method for making trenches. Nor has the Office shown that the skilled artisan would have considered such a limitation obvious in light of the disclosure of Shoji et al. Indeed, in light of the disclosure of Shoji et al. to specifically form grooves, it is doubtful that the skilled artisan would have considered such a limitation to have been suggested by Shoji et al.

Neither has the Office substantiated that the skilled artisan would have been motivated to modify Shoji et al. in light of Yi et al. or Miller et al. Indeed, in light of the express purpose of Shoji et al. to control the shape of the taper of sidewall of the grooves, it is unlikely that the skilled artisan would have been motivated to use the disclosure of Yi et al or Miller et al. to change these express teachings of Shoji et al.

The Office argues that Shoji et al. and Yi et al. teach the recited limitations in claim 20, but recognizes that they do not teach the depth of the trenches and the depth uniformity. The Office relies on Miller et al. for such a teaching, citing column 15, lines 50-67. The Office, however, has not shown that Miller et al. teach the recited trench depth. Miller et al. disclose in this section a trench depth of 1500 to 5000 angstroms. One angstrom is the equivalent of 1×10^{-8} cm, or 1×10^{-10} m. If the undersigned has performed his math correctly, 1500 to 5000 angstroms would therefore be the equivalent of 0.15 to 0.5 micrometers (also known as microns). Thus, the Office has not established that Miller et al. do not describe a trench depth within the claimed range.

For the above reasons, the Office has not substantiated that the skilled artisan would have considered claim 20 obvious over the combined teachings of Shoji et al., Yi et al, and Miller et al. Accordingly, Applicant requests withdrawal of this rejection.

CONCLUSION

For the above reasons, Applicant respectfully requests the Office to withdraw the above grounds of rejection and allow the pending claims.

If there is any fee due in connection with the filing of this Amendment, including a fee for any extension of time not accounted for above, please charge the fee to our Deposit Account No. 18-0013.

Respectfully Submitted,

By 
KENNETH E. HORTON
Reg. No. 39,481

Date: February 21, 2003

APPENDIX A: AMENDMENT TO TITLE

Please amend the title as indicated below:

METHODS FOR ETCHING DEEP SILICON TRENCHES WITH A HIGH
DEPTH UNIFORMITY

APPENDIX B: AMENDMENT TO SPECIFICATION

[33] Next, a mask 24 is provided over the silicon layer 15. Although the mask 24 is illustrated as located on Si layer 15, the mask 24 could also be located over the silicon layer [22] 15, e.g., with intervening layers, films, or other structures. The type and size of mask 24 on the silicon layer 15 can vary depending on the required processing requirements. In one aspect of the present invention, the mask described below is used.

APPENDIX C: AMENDMENT TO CLAIMS

4. (Amended) A method for making a deep trench in a silicon layer, comprising:
 - providing a silicon layer;
 - providing a patterned mask over the silicon layer;
 - etching the silicon layer with a uniform plasma gas comprising a chlorine-containing gas, a passivating gas, a selectivity gas, and a diluent gas; and
 - removing the patterned mask.
11. (Amended) A method for making a plurality of deep trenches in silicon layer, comprising:
 - providing a silicon layer;
 - providing a mask over the silicon layer;
 - etching the silicon layer with a gas mixture comprising a chlorine-containing gas to make a plurality of trenches; and
 - removing the patterned mask;

the plurality of trenches having a depth uniformity of less than about 2 %.
22. (Amended) A method for making a semiconductor device containing a deep trench in a silicon layer, comprising:
 - providing a silicon layer;
 - providing a patterned mask over the silicon layer;

etching the silicon layer with a uniform plasma gas comprising a chlorine-containing gas, a passivating gas, a selectivity gas, and a diluent gas; and
removing the patterned mask.

23. (Amended) A method for making a semiconductor device containing a plurality of deep trenches in a silicon layer, comprising:

providing a silicon layer;

providing a mask over the silicon layer;

etching the silicon layer with a gas mixture comprising a chlorine-containing gas to make a plurality of trenches; and

removing the patterned mask;

the plurality of trenches having a depth uniformity of less than about 2 %.